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Nuclear Experimental Group I

Associate Professors	Tsutomu Tohei and Hikonojo Orihara*
Assistants	Takemi Nakagawa and Takashi Yamaya
Technical Staff	Morio Kato
Secretary	Hiroko Abe
Graduate Students	Susumu Nishihara (D1) and Jun-ichi Hirota (M2)

*Cyclotron and Radioisotope Center,
Tohoku University

Research Activities

(I) LIGHT ION NUCLEAR PHYSICS

a. Nuclear Structure via the $^{152,\ 154}$Sm(p, t)$^{150,\ 152}$Sm Reactions (Y. Ishizaki, T. Hasegawa, Y. Iwasaki, T. Suehiro, K. Miura, S. Hayakawa, J. I. Hirota, T. Nakagawa and T. Tohei)

Even-even samarium isotopes have been studied by the (p, t) reaction at RCNP with $E_p = 65$ MeV, at INS with $E_p = 44$ MeV. The 7^- states in ^{150}Sm at $E_x = 2.925$ MeV and in ^{152}Sm at $E_x = 2.105$ MeV are considered to be two-hole states $[(h_{11/2})^{-1}(d_{3/2})^{-1}]$ in the spherical core of neutron number 82 in deformed nuclei.

b. Fine Structure and Isotope Effects of the Isoscalar LEOR in $^{92,\ 94}$Mo (T. Tohei, J. I. Hirota, T. Nakagawa, T. Saito and M. H. Tanaka)

For a study of isotope effects of the isoscalar LEOR, the $^{92,\ 94}$Mo(α, α')$^{92,\ 94}$Mo reactions have been investigated at INS with $E_\alpha = 65$ MeV. Observed weighted-mean excitation energies E_x of LEOR in $^{92,\ 94}$Mo are 5.8 MeV and 5.1 Mev, respectively. The amounts of the EWSR strength are 19.6 % and 17.3 % for LEOR in $^{92,\ 94}$Mo, respevtively. Present results together with the previous $^{90,\ 92}$Zr data are in excellent agreement with the theoretical ones calculated by RPA except the excitation energy E_x in ^{94}Mo.

c. Preliminary Experiment for Giant Multipole Resonances in ^{90}Zr by Inelastic Alpha Scattering (T. Tohei, T. Nakagawa, T. Saito, J. I. Hirota, T. Yamagata and Y. Fujita)

In order to study fine structure in giant multipole resonances, inelastic alpha particle spectra from ^{90}Zr have been measured at $E_\alpha = 120$ MeV with the RCNP cyclotron and high-resolution magnetic spectrograph RAIDEN.

d. Unnatural Parity States in the ^{208}Pb(α, ^{6}He) Reaction (M. H. Tanaka, S. Kubono, S. Kato, S. I. Hayakawa, K. Morita, T. Nakagawa, R. Asano and M. Igarashi)

Enhanced cross sections for the transitions to 3^+ have been observed in the reaction $^{206}Pb(\alpha, He)^{206}Pb$. These cross sections were well explained by the direct transition of a neutron pair of relative angular momentum $\ell = 1$ as a dominant component.

(II) INELASTIC ELECTRON SCATTERING

Observation of High-Energy Octupole Resonances in ^{62}Ni and ^{92}Zr in Inelastic Electron Scattering (T. Saito, Y. Fujii, K. Saito, Y. Torizuka, J. I. Hirota and T. Tohei)

Giant-resonance regions in ^{62}Ni and ^{92}Zr have been studied by inelastic electron scattering of effective momentum transfer range $0.65 \leq q_{eff} \leq 1.18$ fm^{-1}. A high-energy octupole resonance in ^{92}Zr was identified at $E_x = 25.1 \pm 0.3$ MeV with a width of 6.3 ± 0.3 MeV exhausting 39 ± 4 % of the T = 0 E3 energy-weighted sum rule.

(III) POLARIZATION

a. Vector Analyzing Power of the $(\vec{d}, {}^6Li)$ Reaction at 33 MeV (T. Hasegawa, S. Kubono, N. Ueda, K. Murakami, M. Sugitani, T. Fujisawa, K. Iwatani, T. Yamaya and T. Tohei)

The $(\vec{d}, {}^6Li)$ reaction has been studied on ^{12}C, ^{16}O, and ^{24}Mg with vector polarized deuterons of 33 MeV at INS. Emitted ^6Li particles were detectec with a 80-III counter placed in the focal plane of a QDD magnetic spectrograph. The vector analyzing powers as a function of angle have been obtained for the 0^+ (g.s.), 3^+ (1.63 MeV) and 4^+ (4.25 MeV) states in the reaction $^{24}Mg(\vec{d}, {}^6Li)^{20}Ne$.

b. Polarization Transfer in the (p, p') Reaction on Light Nuclei (J. M. Moss, T. Yamaya and W. D. Cornelius)

The transverse spin-flip probability is measured on ^6Li, ^9Be, ^{11}B, ^{12}C, ^{14}N, ^{16}O, and ^{40}Ca targets in the (p, p') reaction induced by polarized protons in the energy range from 30 to 42 MeV. The spin-flip probability for central forces is shown to be uniquely related to spin transfer (s = 1) in the eikonal approximation.

(IV) SPIN-ISOSPIN MODES IN THE LOW-ENERGY (p, n) REACTION

(H. Orihara, S. Nishihara, T. Murakami, K. Furukawa, M. Kabasawa, T. Nakagawa, K. Maeda, K. Miura, K. C. Kiang and H. Ohnuma)

Spin-mode excitation in nuclei has been investigated by observing the unnatural parity states with $J^\pi = 0^-$, 1^+, 2^-, ... and T = 1 by means of (p, n) experiments. We have utilized high-resolution neutron time-of-flight facilities at Cyclotron and Radioisotope Center, Tohoku University.

a. Giant Gamow-Teller Resonance

Gamow-Teller resonances were observed in the (p, n) reactions on ^{120}Sn, ^{140}Ce and ^{208}Pb at $E_p = 41$ MeV. Experimental results have been compared with predictions by particle-hole plus Δ-hole RPA.

b. Observation of Stretched 4^- and 6^- States in Light Nuclei

The $[\pi d_{5/2}, \nu p_{3/2}^{-1}]_{4^-}$ states in ^{12}N and ^{16}F, and $[\pi f_{7/2}, \nu d_{5/2}^{-1}]_{6^-}$ states in ^{24}Al and ^{28}P have been observed by (p, n) experiments at $E_p = 35$ MeV. It should be noted that the tensor force in the effective nucleon-nucleon interactions plays an important role in these reactions. Quenching of magnetic properties in nuclei were observed.

c. Isovector $0^+ \to 0^-$ Transition Observed in the (p, n) Reaction on ^{16}O

The effects of pion filled in nuclei are expected to be larger for the longitudinal spin response $(\vec{\sigma}\cdot\vec{q})$. The isovector $0^+ \to 0^-$ transition is one of the unique reactions to observe the longitudinal response.

(V) HEAVY ION

Nuclear Molecular Resonances (T. Yamaya, K. Nagatani, N. Takahashi, E. Takada, R. E. Tribble, D. M. Tarner and Y. W. Lui)

Spectra of the (^{16}O, α) reaction induced by a 145 MeV beam strongly suggested the several features that this reaction leads to molecular-like final states for ^{12}C, ^{16}O and ^{20}Ne targets. For ^{13}C and ^{14}N targets, however, a direct ^{12}C transfer to molecular state is not suggested.

(VI) INSTRUMENTATION AND SYSTEM DEVELOPMENT

a. Development of a Small Cold Cathode PIG Type Heavy Ion Source for the Tohoku AVF Cyclotron (T. Yamaya, K. Kotajima, T. Shinozuka, M. Fujioka and Y. Sakurada)

The N^{5+} ion current extracted from a cold cathode type PIG ion source was measured as a function of the arc pulse width. The time dependence on the number of nitrogen ion in the plasma column of a pulsed discharge was calculated to explain the data using the solar corona model.

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